10/590168
IAP6 Rec'd PCT/PTO 18 AUG 2006

[11839/45]

HYDRAULIC POWER STEERING SYSTEM

The invention relates to a hydraulic power steering system for a vehicle, in particular an electrohydraulic power steering system for a motor vehicle, according to the preamble of claim 1.

Hydraulic or electrohydraulic power steering systems for motor vehicles having a servo valve, which is embodied as a rotary slide arrangement and whose control parts - rotary slide sleeve and rotary slide - which are rotatable relative to one another are drive-coupled to one another by means of a torsion element which sets the control parts in a normal position relative to one another, and having a steering gear which is arranged, for the purpose of transmitting drive, between one of the control parts and steered vehicle wheels and is drive-connected directly or indirectly to a hydraulic servo cylinder which is controlled by the servo valve, are known.

A piston rod of the servo cylinder is connected to one or more steerable wheels of the vehicle in a known way via tie rods and steering levers. A toothed rack, which meshes with a pinion of an electric servo motor or a pinion of a mechanical steering shaft connection to a steering handle, is connected in series with the piston rod of the servo cylinder (cf. DE 195 41 749 C1 or EP 0708 011 A2).

The series connection of the piston rod and the toothed rack results in a large installation length of an actuator for an electrohydraulic power steering system. As a result, only relatively short tie rods are possible, which lead to unfavorable kinematics of an axle, to large steering inclination angles and sweep angles of the tie rods and to high loading, in particular in commercial motor vehicles, of an electrohydraulic power steering system and its actuator. In addition, electrohydraulic

power steering systems of said type are designed, in terms of their steering power, for the respective vehicle in which they are used, and are somewhat inflexible in use.

The invention is based on the object of providing an electrohydraulic power steering system which is as compactly designed as possible in the region of its actuator and is suitable for different classes of vehicle.

The object is achieved by means of an electrohydraulic power steering system having the features of claim 1.

An electrohydraulic power steering system, which is suitable in particular for a commercial motor vehicle, and whose actuator is of short design and can be modularly adapted to different power or weight classes of vehicles, is provided in that the piston rod of the servo cylinder and the rack or toothed rack which is axially displaced by the electric servo motor are arranged parallel to one another, and the rack or toothed rack and the piston rod act on an addition member which is in turn operatively connected to the steerable wheel. The rack of the electric servo motor and the piston rod act on the addition member simultaneously and in the same direction.

Preferred embodiments can be gathered from the subclaims.

The rack and the piston rod can be articulatedly connected to the addition member. The rack or toothed rack is however preferably fixedly connected to the addition member. The piston rod is preferably likewise fixedly connected to the addition member, as a result of which the rack, driven by the electric servo motor, and the piston rod perform an axial movement and the addition member, which is embodied as a yoke, is linearly displaced.

Different arrangements of the electric servo motor with the rack, of the servo valve, of the servo cylinder and of their operative connection to one another can also be expedient. In a first, preferred embodiment, the electric servo motor thus acts on a control part, in particular a rotary slide, of the servo valve via a step-down gearing. The control part is in turn rotatably operatively connected to a drive output member, such as a gearwheel which meshes with a recirculating ball nut or a pinion which meshes with a toothed rack. When it rotates, the recirculating ball nut causes, in a known way, an axial displacement of the rack which is embodied as a spindle and in turn acts on the addition member.

It can be expedient for the control part of the servo valve to be rotated not by the electric servo motor, but rather mechanically by a steering shaft with a steering handle, in order to actuate the servo cylinder.

The invention will now be described in more detail on the basis of an exemplary embodiment and represented on the basis of the appended drawings.

Figure 1 shows a schematic longitudinal section of an actuator of a first electrohydraulic power steering system,

Figure 2 shows a further longitudinal section through an actuator of an electrohydraulic power steering system,

Figure 3 shows a further longitudinal section through an actuator of an electrohydraulic power steering system,

Figure 4 shows a schematic longitudinal section through an electrohydraulic power steering system in the form of a double pinion steering system,

Figure 5 shows a schematic longitudinal section through an electrohydraulic power steering system which is embodied as a superposition steering system.

Figure 1 shows a schematic longitudinal section of a linear wheel actuator 19 of a hydraulic power steering system 1 with electromotive assistance of the actuating power of a servo cylinder 4. Two series-connected electric servo motors 6 drive via a gearing 9 a control part 10 of a servo valve 2, said control part being embodied as a rotary slide and being mounted in a coaxial rotary slide sleeve 21. The servo valve 2 is connected to a pressure medium container (not illustrated) and a hydraulic pump, wherein the pressure medium container is connected, in a manner known per se, to a low-pressure connection, and the hydraulic pump is connected to a high-pressure connection. A first working space 23 and a second working space 23' of the servo cylinder 4 are fluidically connected to connections (not illustrated) of the servo valve 2, and are in each case alternately pressurized with pressure medium for the purpose of displacing a dual-acting piston/piston-rod arrangement in the servo cylinder 4. The servo valve 2 has an open center, that is to say all the connections communicate with one another when the control part 10 and the rotary slide sleeve 21 assume a central position relative to one another. The control part 10 and the rotary slide sleeve 21 are connected to one another by means of a torsion bar which is arranged in an axial bore of the parts and attempts to keep the control part 10 and the rotary slide sleeve 21 in their central position relative to one another.

The control part 10 carries a drive output member 11 which is embodied as a gearwheel 12, as a steering nut 13 or as a recirculating ball nut 14 and rotates around, and drives, the rack 7. An addition member 8 is fixed to one end of the rack 7 and is additionally fixedly connected to one end 22 of the piston rod 3, so that the electric servo motors 6 drive both the servo valve 2 for the purpose of actuating the servo cylinder 4, and also the

rack 7 via the recirculating ball nut 14. In the exemplary embodiments shown in figures 1 to 5, the addition member 8 connects the rack 7 and the piston rod 3 to one another at right angles. The rack 7 and the piston rod 3 are arranged parallel to one another and without longitudinal offset, and jointly act on the addition member 8 which fixedly connects the two and is embodied as a yoke 24. The parallel- arrangement of the rack 7 with the servo cylinder 4 results in a short design of the wheel actuator 19 and of the electrohydraulic power steering system.

The electrohydraulic power steering systems shown in a schematic longitudinal section in figures 2 and 3 are of identical arrangement with identical coupling of the rack 7 and the piston rod 3 to the addition member 8. The electric servo motor 6 drives the control part 10 via a gearing 9, said control part 10 in turn acting on the rack 7 via a drive output member 11 for the purpose of axially displacing said rack 7 (cf. figure 2). A steering shaft 16 is rotationally fixedly connected to the control part 10. In figure 3, the steering shaft 16 drives the control part 10 of the servo valve 2 which acts on the rack 7 via a drive output member 11 which is embodied as a pinion 15. A step-up gearing 9 is arranged, with the electric servo motor 6, between the control part 10 and the drive output member 11, said electric servo motor 6 acting on the drive output member 11.

Figures 4 and 5 illustrate schematic longitudinal sections through an electrohydraulic power steering system. In figure 4, the electric servo motor 6 acts on the rack 7 via a gearing 18, while the servo valve 2 and its control part 10 are rotationally fixedly connected to the steering shaft 16 and act on the rack 7 via the drive output member 11 (double pinion steering system).

In figure 5, the electric servo motor 6 acts on the drive output member and the rack via a superposition gearing 17 between the servo valve 2 and the drive output member 11.